AP Chemistry
Semester Exam
Instructor's Version

Answers to Section I (Multiple Choice Sheet)

1.	C
2.	D
3.	A
4.	E
5.	C
6.	A
7.	C
8.	E
9.	C
10.	B
11.	A
12.	E
13.	C
14.	B
15.	D
16.	E
17.	A

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Answers to Section II (Free Response)

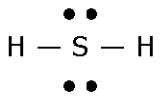
Time Limit: You have 60 minutes to complete this section.
Scoring: 164 points total; question 1 is worth 63 points, question 2 is worth 50 points, and question 3 is worth 51 points; points for each section are indicated within the question.
Calculator Use: You may not use a calculator on question 1. You may use a calculator on questions 2 and 3.

1. For each of the following molecules:

A. Draw the Lewis electron dot structure. (8 points each)
B. Describe the molecular geometry. (8 points each)
C. Determine whether or not the molecule is polar, and explain your reasoning. (5 points each)

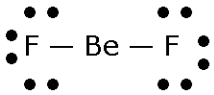
H_2S BeF_2 PF_3

Answer:
H_2S



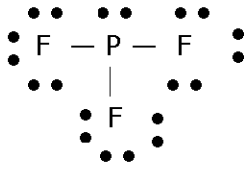
Molecular geometry: bent (2 bonding pairs, 2 lone pairs on S)
Asymmetric, bent geometry gives molecule a nonzero dipole so it is polar.

BeF_2



Molecular geometry: linear (2 bonding pairs, 0 lone pairs on Be)
Symmetry makes the molecule nonpolar.

PF_3



Molecular geometry: trigonal pyramidal (3 bonding pairs, 1 lone pair on P)
Net dipoloe in the direction of the lone pair makes the molecule polar.

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2. The first step in the manufacture of sulfuric acid is the combustion of hydrogen sulfide to produce sulfur dioxide and water. The standard enthalpy of this reaction is −562.5 kJ/mol. The molar heat capacity of sulfur dioxide is 30.2 J/mol • K and its density is 2.62 g/L at 25.00°C and 1.00 atm.

A. Write a balanced equation for the combustion of hydrogen sulfide to produce sulfur dioxide and water. (10 points)

Answer:
H_2S (g) + 3/2 O_2 (g) → SO_2 (g) + H_2O (l) **OR**
2 H_2S (g) + 3 O_2 (g) → 2 SO_2 (g) + 2 H_2O (l)

B. How much heat is released when 5.00 L of sulfur dioxide is produced, if the gas is collected at 1.00 atm and 25.00°C? (20 points)

Answer:
Use ideal gas law to find moles of gas produced:
n = PV/RT = (1.00 atm)(5.00 L)/(0.0821 l • atm/mol • K)(298.15K)
= 0.2043 moles SO_2
Since 1 mole SO_2 is produced from 1 mole H_2S, moles H_2S also equals 0.2043.
Then use standard enthalpy of reaction to find heat released:
(0.2043 moles)(−562.5 kJ/mol) = −115 kJ released

C. The next step in the production of sulfuric acid is to raise the temperature of the 5.00 L of sulfur dioxide. What fraction of the heat produced by the combustion of 5.00 L of sulfur dioxide will be used to heat it from 25°C to 500°C? (20 points)

Answer:
Use the molar heat capacity to calculate the heat required to raise T by 475 degrees:
(30.2 J/mol • K)(0.2043 moles)(475K) = 2.93 kJ
Fraction used = 2.93 kJ/115 kJ = 0.0255

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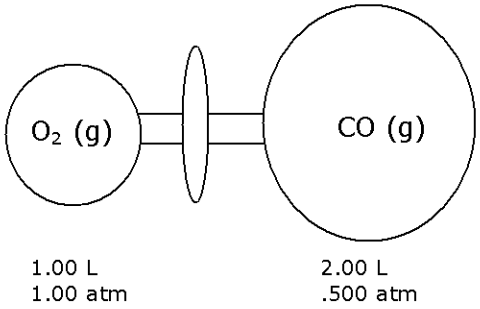
3. Carbon monoxide and oxygen are kept at exactly 300 K in separate chambers of the apparatus shown below. When the stopcock is opened, the combustion reaction begins and is allowed to proceed to completion, while being maintained at exactly 300 K.



A. Write a balanced equation for this reaction. (5 points)

Answer:
2 CO (g) + O_2 (g) → 2 CO_2 (g)

B. How many moles of each reactant are present before the reaction begins? (16 points)

Answer:
O_2: n = PV/RT = (1.00 atm)(1.00 L)/(0.0821 L • atm/mol • K)(300 K) = 0.0406 moles
CO: n = PV/RT = (0.500 atm)(2.00 L)/(0.0821 L • atm/mol • K)(300 K) = 0.0406 moles
(note: treat the 300 K as exact, based on wording of problem, so this does not limit the number of sigificant figures)

C. How many moles of each gaseous reactant and product are present when the reaction goes to completion? Assume the connecting tube has negligible volume. (15 points)

Answer:
CO: limiting reagent, gets completely consumed so moles at completion = 0
O_2: 0.0406 moles initially – 0.0203 moles needed to react with the CO = 0.0203 moles left
CO_2: moles produced = moles CO consumed = 0.0406

D. What is the partial pressure of each gas when the reaction goes to completion? Assume the connecting tube has negligible volume. (15 points)

Answer:
CO: moles = 0 so partial pressure also equals 0.
O_2: P = nRT/V = (0.0203 moles)(0.0821 L • atm/mol • K)(300K)/3.00 L = 0.167 atm
CO_2: P = nRT/V = (0.406 moles)(0.0821 L • atm/mol • K)(300K)/3.00 L = 0.333 atm

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